Abundances and Isotope Ratios in N113

M. Wang, (PMO/Nanjing) Y.-N. Chin, (Tamkang Univ./Taipeh) C. Henkel, (MPIfR/Bonn) J.B. Whiteoak, (ATNF/Epping) M. Cunningham (UNSW/Sydney)

Goal:

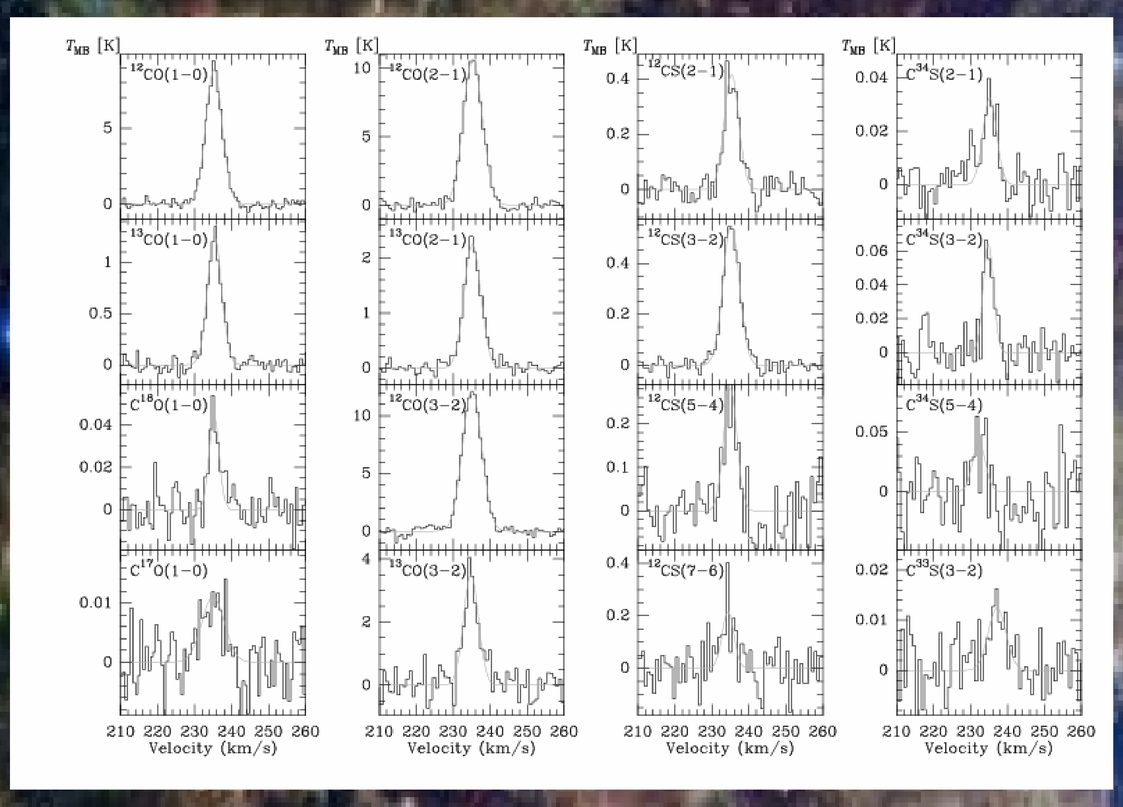
Physical and chemical conditions of star formation in the Magellanic Clouds

Source:

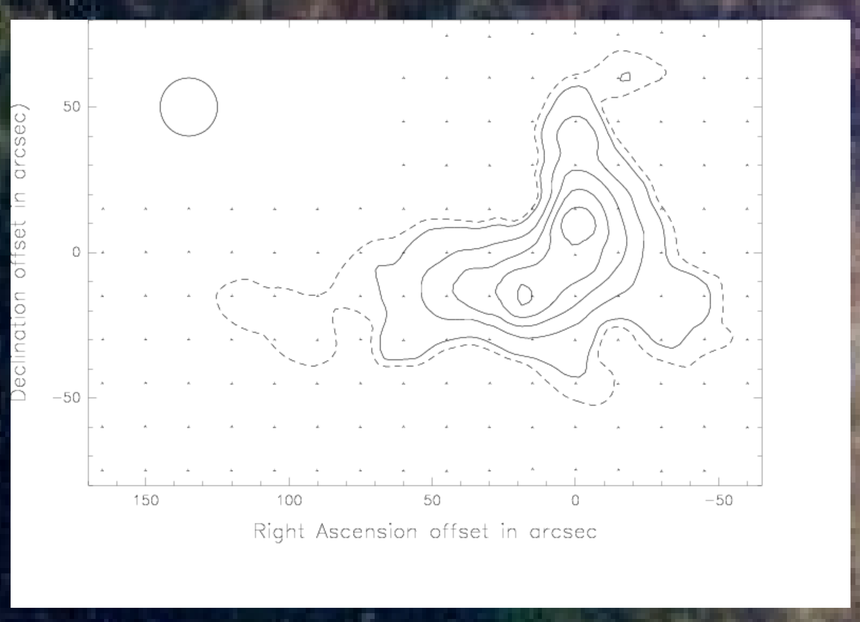
N113, one of the two sources with strongest molecular line emission, located in the central region of the LMC.

Project:

1–3 mm spectral line survey, covering 63 molecular transitions of 16 species between 85 and 357 GHz + a 1.3mm continuum map.
Telescopes: SEST and APEX.



Some of the SEST spectra (CO and most CS lines)



APEX CO J=3–2 map,
7, 10, 20, 30, 40, 50 K km/s (T_A^*)

Analysis:

Large Velocity Gradient modeling to evaluate density and temperature. LTE approach in the case of CN and a few other species where the number of observed transitions was small or where collision rates with H_2 were not available.

Results:

$M_{N113} \sim 3\times10^5$ M

N_{H2} $\sim 2\times10^{22}$ cm^{-2} (central 45” / 11 pc)

N_{H2} $\sim 1\times10^{23}$ cm^{-2} (central 24 “ / 5.5 pc)

Virial equilibrium:
$N_{CO}/N_{H2} = 4\times10^{-5}$ (central 45”)
$X = N_{H2}/I_{CO\ J=1-0} = 3.4\times10^{20}$ cm^{-2} (K km/s)$^{-1}$ (45”)

Average $\langle n_{H2} \rangle = 500$ cm^{-3} (central 45” / 11 pc)

CO	⇒	$n_{H2} \sim$ 5000 cm^{-3}
C_3H_2, CH_3OH	⇒	$n_{H2} \sim$ 30000 cm^{-3}
CS, HCN, HCO$^+$	⇒	$n_{H2} \sim$ 300000 cm^{-3}

Chemistry: N113 is a photon dominated region in an environment that is nitrogen deficient.
NO and HNCO remain undetected.

An ortho-to-para H_2CO abundance ratio of ~3 indicates that at least formaldehyde was formed in a warm (at least several 10 K) environment.

Optical depths: The main lines of CS, HCN, and HCO$^+$ are only moderately opaque ($\tau \sim 0.5$), CO is optically thick ($\tau \sim 10$), and ^{13}CO is optically thin.

Isotope ratios: The interstellar medium of the LMC is well mixed. Carbon, nitrogen, and oxygen isotope ratios demonstrate that the outer Galaxy does not provide a “bridge”” between the solar neighborhood and the LMC. This is likely caused by the high age of the stellar population of the LMC relative to that of the outer Galaxy. Adopting this scenario, observed carbon and oxygen isotope ratios are qualitatively understood, while nitrogen and sulfur ratios remain an enigma.